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Fact Sheet
Air Toxics Monitoring: Overview

What do we use air toxics monitoring for?

Air toxics monitoring serves numerous purposes such as:

- Measuring air toxics emission rates from individual pollution sources
- Measuring an individual's exposure to pollutants over an extended period of time
- Ensuring worker safety by measuring an individual's short-term exposure to pollutants
- Comparison with results of computer models (dispersion and exposure) for evaluation and calibration of the models
- Providing information on spatial (space) and temporal (time) variability of air toxic concentrations
- Characterizing ambient concentrations and deposition in representative monitoring areas (for example, evaluations of air toxic deposition to the Great Lakes)
- Establishing trends and evaluating the effectiveness of HAP reduction strategies.

Results of air toxics monitoring already conducted may help state/local/tribal air agencies in identifying their particular monitoring network needs. For example, the 1996 National Toxics Inventory (NTI) is a compilation of air toxics pollutant emission rates from all man-made sources in the nation. As part of a current national screening assessment, we are using the NTI data together with a nationwide dispersion model called ASPEN (Assessment System for Population Exposure Nationwide) to estimate ambient levels of air toxics. State/local/tribal organizations can use the ASPEN modeling results to help site new monitors.

Who conducts air toxics monitoring?

With the variety of applications of air toxics monitoring data, there are a variety of organizations that may conduct monitoring:

- Federal agencies (for example, EPA)
- State/local/tribal agencies with environmental interests
- Commercial interests
- Educational/research institutions
- Community organizations (such as for environmental justice concerns).

We are currently implementing a National Air Toxics Program designed to characterize, prioritize, and equitably address the impacts of HAPs on the public health and environment. One key area of activity serving the program is the National Air Toxics Assessment (NATA), which includes air toxics monitoring.

How is an air toxics monitor located?

Monitors may be located at temporary sites, located on movable platforms, located on vehicles, located at fixed sites (for long-term use), or carried by an individual (clipped onto clothing or attached to a harness). They may be used indoors, immediately outside a building, or in an open outdoor area.

Locations of monitors in a monitoring network will depend on the spatial scale for which the network was designed. The spatial scale describes the physical dimensions of the airspace around a monitor throughout which pollutant concentrations are reasonably similar. The spatial scales defined in 40 CFR Part 58, Ambient Air Quality Surveillance, Appendix D, are:

- Microscale--defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters
- Middle Scale--defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer
- Neighborhood Scale--defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range
- Urban Scale--defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition.
- Regional Scale--defines usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers
- National and Global Scales--these measurement scales represent concentrations characterizing the nation and the globe as a whole.

How do air toxics monitors work?

With differences in how air samples are collected and analyzed, there are many types of air toxics monitors. To describe some differences in monitor types, the monitors are grouped as follows:

- **Passive monitor.** The passive monitor collects airborne pollutants by absorption onto a reactive material (for example, sorbent tube, filter) for subsequent laboratory analysis. No pump is used to draw the air across the reactive material. This type of monitor is typically used for personal exposure monitoring or work space monitoring.

- **Personal air monitoring device.** Unlike a passive monitor, this device uses a pump to draw the air sample through. The air sample can be drawn across a reactive material (to be analyzed in a laboratory), or it can be drawn through a direct-read detector.
- **Grab-sampling device.** This is a self-contained device that does not rely on a pump to collect a whole-air sample. An example of this type of monitor is a canister under vacuum. The canister, which may be fitted with a fixed orifice, relies on its own vacuum to draw in air until it comes to ambient pressure. The grab sample is subsequently analyzed in a laboratory.
- **Integrated air sampling device.** This device uses a pump to draw the air sample. The air sample is drawn across a reactive material or into a collection vessel (for example, canister). The pump can be programmed to run for a preset period of time (for example, 1 hour, 24 hours). The sample is subsequently analyzed in a laboratory.
- **Direct-read monitor.** Using a pump to draw the air sample through a detector, this type of device provides a direct reading of the pollutant measurement. The monitor may be designed as a table-top unit, for example, or it may be rack-mounted such as for use in an ambient air monitoring station.
- **Automated monitoring system.** This is a fully automated system to sample the air, analyze for the pollutant of interest, and report the resulting data. Calibration of the analyzer (for example, gas chromatograph, mass spectrometer) is also automatic. Analyzer control and data retrieval may be performed remotely via modem connection.
- **Air deposition monitor.** There are two major types of sampling instruments in use: precipitation collectors for wet deposition; and air samplers to measure toxics in the particulate and vapor phases. However, there are variations. The air deposition network is generally comprised of both active and passive, wet and dry sampling systems.

Air toxics monitors may be used for ambient monitoring, air deposition monitoring, or personal exposure monitoring. These types of monitoring are described in sections below.

In what format are monitoring data results available?

Monitoring data results may be reported in real time, if the air sample is analyzed in real time, or the results may be converted into averages over time (for example, hourly, daily, seasonal). Monitoring data results may be reported as emission rates (for example, pounds per hour) or as concentrations (for example, parts per million by volume).

Our Office of Air Quality Planning and Standards (OAQPS) maintains the AIRData website, which gives you access to yearly summaries of air pollution data (emissions and monitoring) for the entire United States. In AIRData, you'll find information on criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, particulate matter, and lead) and on hazardous air pollutants. Data available through AIRData are extracted from three EPA databases:

- AIRS (Aerometric Information Retrieval System) database. Provides air monitoring data--ambient concentrations of criteria air pollutants at monitoring sites, primarily in cities and towns.
- NET (National Emission Trends) database. Provides estimates of annual emissions of criteria air pollutants from point, area, and mobile sources.
- NTI (National Toxics Inventory) database. Provides estimates of annual emissions of hazardous air pollutants from point, area, and mobile sources.

For general information about the AIRData website, see http://www.epa.gov/air/data/info.html. The Air Quality Subsystem (AQS) is a subsystem of AIRS that contains measurements of ambient concentrations of air pollutants and associated meteorological data. You may obtain data from the AIRS AQS data tables through http://www.epa.gov/aqspubl1/select.html.

Monitoring data are also available indirectly through a database that is under development, the National Air Toxics Deposition Monitoring and Modeling Meta-Database. Development of this database is part of an effort by OAQPS to catalog air toxics deposition and modeling activities conducted by various public and private instititutions and organizations. This Meta-Database provides location-specific information on deposition monitoring activities, such as pollutants monitored, sampling frequency, dates of monitoring, watershed, and geographical location. To initiate population of the database, over 500 websites were searched for deposition data, more than 50 contacts were made to organizations involved in deposition monitoring and modeling, and over 100 abstracts were reviewed. Seventeen pollutants and classes of pollutants were targeted, including persistent organic pollutants (POP), persistent bioaccumulative toxics (PBT), mercury, lead, and cadmium, among others. The Meta-Database itself does not contain any deposition monitoring data; however, it does provide query capabilities, site addresses, and electronic address connection to sites that hold the air data (see "Where can you find more information on ambient monitoring?" below).

How are ambient monitors used?

Ambient air monitoring data are needed to characterize air toxics ambient concentrations and toxics deposition, to better understand the transport and fate of air toxics in the atmosphere and to help evaluate atmospheric dispersion and deposition models.

Ambient air and pollutant deposition monitoring may be used to determine:

- Highest concentrations expected to occur in the area covered by the monitoring network
- Representative concentrations in areas of high population density

- Impact on ambient pollution levels of significant sources or source categories
- General background concentration levels
- Extent of regional pollutant transport among populated areas
- Welfare-related impacts in more rural and remote areas.

In some instances, short-term ambient monitoring is desired. These temporary monitoring activities can be useful to:

- Facilitate proper assessments of geographic variability
- Characterize environmental justice concerns
- Assess ambient concentrations representative of small geographic areas like schools, which may be potentially impacted by specific sources ("hot spots").

Practically, ambient measurements cannot be made everywhere, so modeled estimates are used to extrapolate our knowledge of air toxics impacts into locations without monitors. That is, modeling tools work together with monitoring networks.

Ambient air monitors do not directly estimate long-term human inhalation exposures. Such exposures are either measured with personal monitors, which follow a human subject through time and space, or predicted with exposure models, which simulate long-term human activities. However, ambient monitors can indirectly provide information that is essential to a proper exposure and health risk characterization. Research has shown a predictable relationship between concentrations of air toxics from ambient monitoring and concentrations of air toxics in the microenvironments (for example, home, vehicle, workplace) that are of interest in exposure assessments. Therefore, ambient monitor data can successfully be used as input for exposure models such as to predict human inhalation exposure concentrations.

Where can you find more information on ambient monitoring?

Through the Technology Transfer Network, our Ambient Monitoring Technology Information Center (AMTIC) provides information on ambient air quality monitoring; see http://www.epa.gov/ttn/amtic/moninfo.html.

Until the National Air Toxics Deposition Monitoring and Modeling Meta-Database is fully uploaded to our Technology Transfer Network's Air Toxics Web site, see the working site at http://209.42.208.126/NATMonitor.

How are personal exposure monitors used?

Personal exposure monitors come in several types. Personal monitoring badges, which are about the size of a credit card, are one method used to collect exposure data. Other personal air monitoring systems may be pump-assisted. Commonly monitored air toxics include formaldehyde, ethylene oxide, and aromatic hydrocarbons.

Some personal air monitoring systems that are commercially available:

- For organic vapor, ethylene oxide, and formaldehyde. A monitor samples airborne contaminants by the simple process of diffusion. The monitor is lightweight, approximately the size of a key ring, and can be clipped to a shirt lapel, collar, or pocket, for example.
- For ozone. A clip-on badge provides two ozone measurements: a one-hour peak exposure and an eight-hour average exposure, calibrated in ranges of 10 ppb to 350 ppb.
- For particulate matter. A personal particulate monitor passively samples surrounding air that circulating by natural convection, diffusion, and background air motion. The monitor is palm-sized and weighs 18 ounces. The range of maximum response is particle sizes ranging from 0.1 to 10 um. A similar model uses a pump module to additionally perform aerodynamic sizing (particle size-selective measurements).

So far, personal exposure monitors have been developed and used primarily by non-EPA organizations, and data are limited. Thus, most inhalation exposure characterizations have relied on model predictions using ambient monitoring data.

What air toxics monitoring activities are taking place or planned?

According to an estimate in the Air Toxics Monitoring Concept Paper (February 2000), there are approximately 300 sites currently collecting ambient data on hazardous air pollutants and other air toxics, through a combination of Federal, state, local, and tribal monitoring activities.

Selected air toxics monitoring activities are described below, to provide some idea of the diversity of applications:

- The Photochemical Assessment Monitoring Stations (PAMS) program has collected air toxics data for 9 VOC HAPs since 1993 in more than 20 major urban areas.
- As part of EPA's efforts to assess regional haze, 10 HAP metals are being measured at over 50 urban locations in the country, through the IMPROVE and CASTNET networks. IMPROVE will be expanded to 110 Class I monitoring areas. CASTNET also monitors 8 rural sites in the eastern U.S.
- The Mercury Deposition Network (MDN), a sub-network of the National Atmospheric Deposition Program (NADP), provides regional measurements of mercury deposition in

precipitation at 37 sites, while the Great lakes and National Estuary Program networks measure a variety of HAPs at more than a dozen sites.

- A dioxin monitoring network known as the National Dioxin Air Monitoring Network (NDAMN) began operation in 1998, measuring background atmospheric levels of dioxin-like compounds in rural U.S. locations. The sampling medium has two components--one to collect particulate matter and another to collect gaseous-phase compounds. Additional information may be found through a search of our Environmental Information Management System (EIMS) at http://oaspub.epa.gov/eims/eimsstart/.
- We are currently participating in a monitoring pilot project commonly called the "National Air Toxics Monitoring Pilot Program," to generate information on the spatial and temporal variability of ambient air toxics concentrations. Ten state/local agencies are participating in this project, each one representing a different geographical area of the country and each one sampling for at least the project's core list of 18 air toxics compounds. The data generated from this study, along with the data currently in our data archive of the 300 sites noted above, will provide the basis for a National Air Toxics Monitoring Network Design. The design, being developed by EPA, state, and local experts, has an expected completion date of early fiscal year 2003.
- One EPA-sponsored project involves about 100 volunteer households in Oklahoma, using personal monitoring to measure exposure to VOC HAPs to include benzene, toluene, ethylbenzene, xylenes, styrene, n-hexane, and 2,2,4-trimethylpentane. See http://es.epa.gov/ncerqa_abstracts/grants/98/urban/esmen.html.
- Another EPA-sponsored project involves residents from three communities in the Minneapolis-St. Paul Metropolitan Area, using personal exposure monitors for VOC and PM2.5. The PM2.5 samples were analyzed for six metals (As, Cd, Cr, Pb, Mn, and Ni using ICP/MS. VOC measurements included benzene, carbon tetrachloride, chloroform, 1,4-dichlorobenzene, methylene chloride, styrene, tetrachloroethylene, and toluene. See http://es.epa.gov/ncerqa_abstracts/grants/99/urban/adgate.html.
- A project proposed in 1999, to be sponsored by the State of California Air Resources Board, involves mobile air monitoring vans to measure air pollutants at schools and selected neighborhoods in Fresno County, California. Indoor and outdoor air samples will also be taken from participants' homes. This is a study of the responses of asthmatic children to particulate air pollution. While the project is categorized as an air toxics exposure assessment, particulate matter is the only pollutant to be assessed that might be considered an air toxic. The study is proposed by the School of Public Health, University of California, Berkeley, California.

For information on specific monitoring stations/networks or specific modeling activities that relate to atmospheric deposition, you can search the National Air Toxics Deposition Monitoring and Modeling Meta-Database (see "Where can you find more information on ambient monitoring?" above).

What methods are useful to analyze air monitoring samples?

It is not possible to measure all air toxics at all locations. Recognizing this, we have developed a subset of the 188 HAPs thought to have the greatest impact on the public and the environment in urban areas. This subset, comprising 33 HAPs, is identified in our Urban Air Toxics Strategy (UATS). For the near term, many monitoring efforts are primarily focused on these 33 UATS HAPs.

For 27 of the 33 UATS HAPs, there are standard methods to collect and analyze the monitoring samples. These are described in Table 1.

As technology develops, continuous and less labor-intensive monitoring equipment for some HAPs should become available. A new commercially available continuous formaldehyde analyzer is currently undergoing field evaluation. Continuous total and speciated mercury monitors are currently commercially available.

Table 1. Selected Collection/Analysis Methods

Name of Collection/Analysis Method	Types of Air Toxics Sampled/Analyzed by Method
Toxic Compendium Method TO-15, "Determination of Volatile Organic Compounds in Air Collected in Specially-prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry, GC/MS,"	VOC HAPs
TO-14A, "Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas Chromatography."	VOC HAPs
Compendium Method IO-3, "Chemical Species Analysis of Filter-collected Suspended Particulate Matter, Overview." [Note: Analysis of some metals would require more specific analytical techniques than this one [for example, mercury and valence-specific metals like chromium VI (hexavalent chromium).]	As many as 11 HAP metals
Compendium Method IO-3.5, "Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma/Mass Spectrometry, ICP/MS."	HAP metals (antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, selenium)
Toxic Compendium Method TO-11A, "Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography, HPLC."	Aldehyde HAPs (formaldehyde, acetaldehyde, propionaldehyde)
Toxic Compendium Method TO-13A, "Determination of Benzo(a)pyrene and other Polynuclear Aromatic Hydrocarbons in Ambient Air Using Gas Chromatography with Mass Spectrometry."	Polynuclear aromatic hydrocarbons (PAHs)
Toxic Compendium Method TO-4A, "Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/Multi-Detector (MD)."	Hexachlorobenzene

Table 1. Selected Collection/Analysis Methods (cont'd)

Name of Collection/Analysis Method	Types of Air Toxics Sampled/Analyzed by Method
Toxic Compendium Method TO-9A, "Determination of Polychlorinated, Polybrominated and Brominated/Chlorinated Dibenzo-p-dioxins and Dibenzofurans in Ambient Air." [Note: This method is reported to be resource-intensive and expensive.]	2,3,7,8-tetrachlorodibenzo-p-dioxin and congeners and TCDF congeners

Notes:

The "TO" (Toxic Compendium) methods are available through our Technology Transfer Network at http://www.epa.gov/ttn/amtic/airtox.html.
The "IO" (Inorganic Compendium) methods are available through our Technology Transfer Network at http://www.epa.gov/ttn/amtic/inorg.html.